Original articles

J. Perinat. Med.
14 (1986) 87

Experience with the Bamberg obstetrical forceps

Peter Krieglsteiner[1], Heinrich Adolf Krone[2], and Dieter von Zeppelin[1]

[1]Department of Obstetrics and Gynecology and Out-Patient Department, University Hospital, Technical University of Munich, and
[2]Department of Obstetrics and Gynecology, Bamberg Main Hospital, Fed. Rep. Germany

1 Introduction

Since its introduction by MALMSTRÖM [14] in 1954, use of the vacuum extractor has surpassed that of forceps delivery in Europe [14, 15]. The ease and presumed safety with which the vacuum extractor can be applied, coupled with the ability to apply this instrument to the fetal vertex, prior to the cervix having obtained full dilatation, has been responsible for this trend. However, vacuum extraction has been shown to be associated with a significant risk of trauma and fetal cephalhematomas [17]. This has led to a renewed interest in the development of alternative varieties of obstetrical forceps and safer techniques of forceps delivery.

Clinical experience has shown that the performance of outlet forceps deliveries expedites birth in cases of fetal distress and that the use of parallel forceps such as the SHUTE variety offers significant advantages in protecting the fetal cranium during the extraction process [20, 21].

Earlier varieties of obstetrical forceps still in use, especially those with crossed shanks, often produce a significant amount of trauma both to the fetus and the mother [1]. Their application to the fetal head produces a significant degree of compression during the extraction process, thereby increasing the risk of local tissue injury, intracranial damage and local nerve palsies [5]. Moreover, the blades of these forceps characteristically have a wide pelvic cure which tends to distend and traumatize soft tissues of the pelvic outlet during the process of extraction.

In Germany, the NAEGELE and KIELLAND forceps are the most widely used crossed shank varieties. The SHUTE type is the most commonly employed parallel forceps, while the LAUFE forceps [12, 18] is the most commonly used instrument with divergent blades. Unfortunately, use of the above varieties of obstetrical forceps are associated with an unacceptably high incidence of complications [8].

This paper presents our experience with a new instrument, the divergent Bamberg forceps, which we believe offers distinct advantages over other varieties currently in use in Germany.

2 Materials and methods

In 1975, a new obstetrical forceps was developed at the Bamberg Obstetrical Clinic in West Germany [22]. This forceps is presented in figure 1. Since its introduction, the Bamberg forceps has been widely used, both at the Bamberg Obstetrical Clinic and in the Obstetrical Department of the Technical University of Munich.

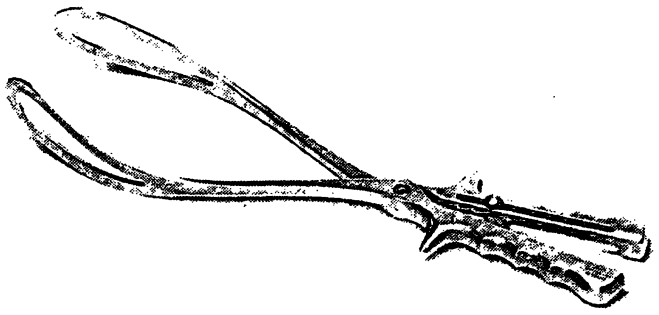

Figure 1. Bamberg divergent forceps (conventional design, ZEPPELIN Medizintechnik GmbH, D-8023 Pullach/München F.R.G.). The slide mechanism ensures automatic limitation of the applied force and constant fixation of the blades on the fetal head.

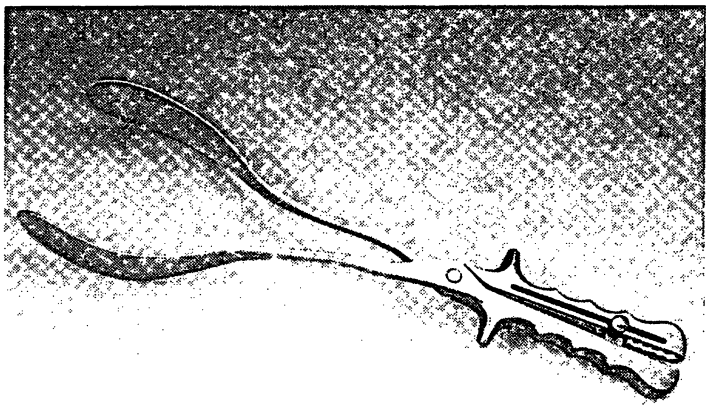

Figure 2. Bamberg divergent forceps (advanced design with closed blades). The slide mechanism is unchanged. To prevent pelvic injuries, the closed blade surface are coated on the outside with teflon [10].

We contend that a major advantage that the Bamberg forceps has over other varieties lies in the fact that it makes efficient use of the divergent arrangement of its blades and handles about a common pivot — the tapered pin lock.

The forces that are applied directly or indirectly to the fetal head during the application of forceps and during the extraction process are four in number (figure 2) [10].

Applied force — A 1; Extraction force — E
Contact force — A 2; Compressive force — C

Once introduced into the vagina and applied to the fetal head, the blades of the Bamberg forceps can be made to mold by simply adjusting the slide mechanism on the handle. The degree of head compression as well as the applied force involved during the extraction can be evaluated by the following equation:

$$A\,1 = \frac{\mu}{\cos\beta} \cdot S \cdot \sin\alpha \cdot \cos\frac{\alpha}{2} \qquad \text{(figures 3 and 4)}$$

Based on this formula, a sliding force of s = 2 kp will produce an applied force of only 0.1 kp. The fact that the eccentrically arranged slide lock will lock automatically whenever the forceps handles are forced together, makes it

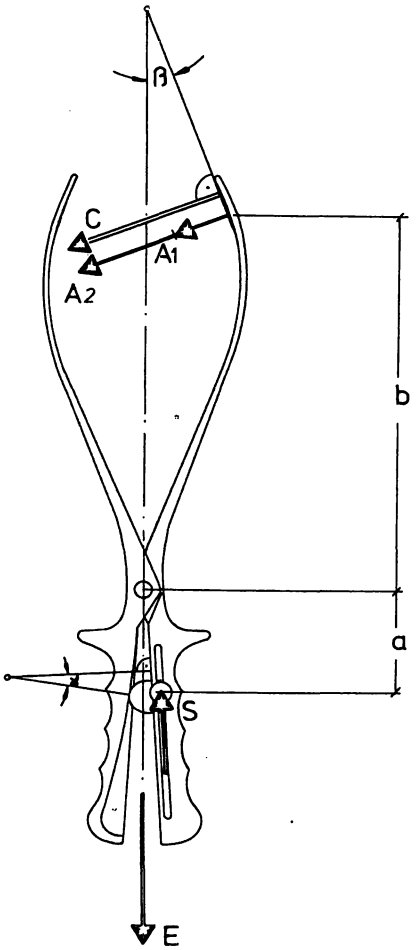

Figure 3. The forces occurring during extraction: the compressive force C acting on the fetal head can be resolved into components A 1 (applied force) and A 2 (contact force). The forceps design guarantees an applied force of maximum 300 g.

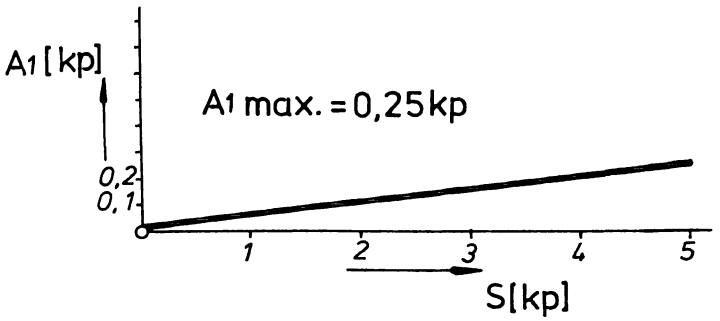

Figure 4. Applied force A 1: The sliding force 's' exerted by the excentric on the sliding curve (right blade) with normal manual pressure gives rise to an applied force A 1 of maximum 300 g. This force remains constant during extraction.

impossible to increase the applied force inadvertantly during extraction of the fetus. This renders the Bamberg obstetrical forceps especially useful in cases of mild to moderate cephalopelvic disproportion and represents a unique feature not found with any other obstetrical forceps. The use of the Bamberg forceps enables applied force to remain constant during the extraction with a theoretical maximum of 300 g.

An additional force which is superimposed on the applied force during the extraction process is the contact force (A 2). This force is directly proportional to but less than the extraction force (E). The sum of the applied force (A 1) and the contact force (A 2) equals the compressive force (C), which is exerted to the fetal head.

This can be expressed as follows:

$$\vec{C} = \vec{A}1 + \vec{A}2 = \vec{A}1 + E(\sin\beta) \text{ (figure 5)}$$

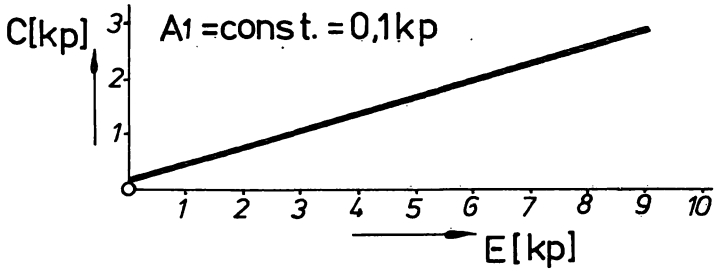

Figure 5. Compression force C: With a normal and constant applied force A 1 of 0.1 kp the compressive force acting on the fetal head is only a function of the extraction force. This in turn, is dependend on the station of the head in the pelvis and can thus be influenced by the operator's range of indications.

3 Results

We have performed 483 forceps deliveries using the Bamberg divergent forceps. In addition to this number, there were 36 cases where the Bamberg forceps was used in conjunction with a vacuum extraction.

These forceps deliveries represent approximately 3% of all births at the two institutions (figure 6). In approximately 50% of cases, the indication for forceps delivery was acute fetal distress, while in about 40% of the cases, the indication for forceps delivery was delay in the second stage of labor.

Additional indications for forceps delivery include factors such as malposition of the fetal head and assistance in the case of maternal disease. 84% of the forceps deliveries were outlet procedures, while 14% were low-mid-forceps. In the last years of this study outlet procedures were performed almost exclusively.

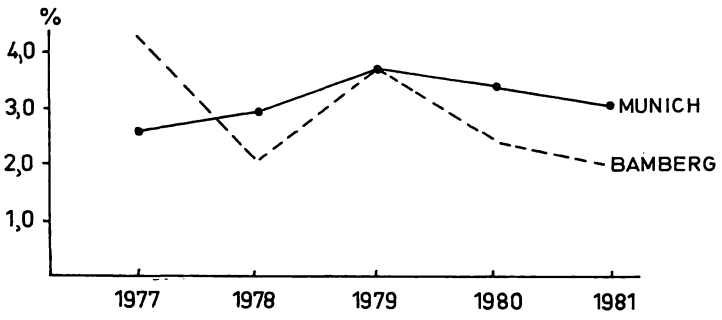

Figure 6. Proportion of forceps deliveries in total collective.

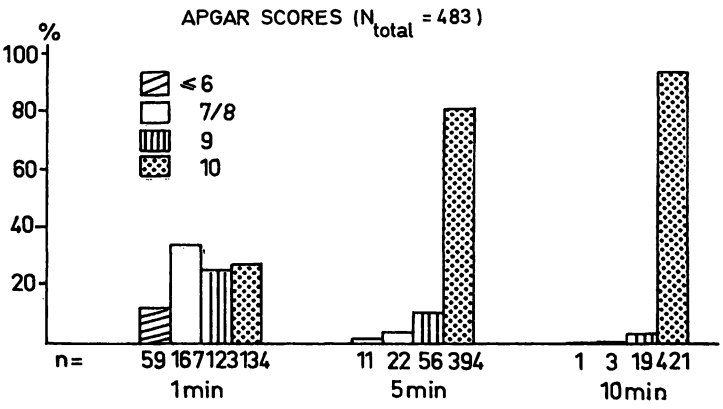

Figure 7. Apgar scores.

Table I. Fetal injuries.

	divergent forceps (n = 483)	
	n	%
external hematomas	50	10.4
peripheral paralysis	9	1.9
clavicular fractures	7	1.4
abrasions, pressure scores	6	1.2
neonatal seizures	4	0.8
neonatal death (multiple malformations)	1	0.2

A retrospective analysis of Apgar scores at 1, 5 and 10 minutes is presented in figure 7. Only 10% of cases were associated with mild to moderate degrees of fetal trauma, such as abrasions, bruises and hematomas. No serious sequelae were noted on follow up (table I).

4 Discussion

In Europe, the incidence of forceps delivery is significantly lower that in the United States [4] and Australia [7], where one-fourth to one-third of all deliveries are assisted with obstetric forceps. However, there has in recent times been an increase in the relative number of forceps deliveries as compared to vacuum extractions performed in Europe. This appears to have stemmed from the fact that currently, almost all labors are being electronically monitored, which in turn has resulted in a tendency towards early intervention as soon as "suspicious" fetal heart rate tracings are detected during the second stage of labor. The result is that more forceps deliveries are being performed for fetal distress than has been the case in the past [3, 4, 9, 16, 19, 23]. The fact that most German obstetricians still regard vacuum extraction as a safer procedure than forceps delivery [2, 6] has recently been contested [20]. We similarly contend that not a single study has conclusively shown that vacuum extraction is safer than forceps delivery, and our data is in support of this view.

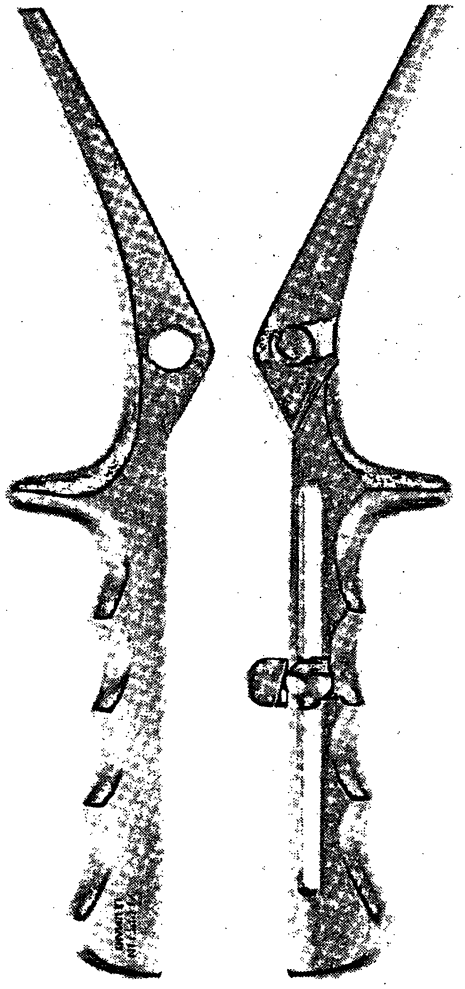

Figure 8. Bamberg divergent forceps: Lock with pivot in the left and cavity in the right handle.

Numerous studies support the contention that divergent forceps provide the safest option with regard to assisted outlet deliveries [1, 7, 11, 12, 13]. Our own experience with the divergent Bamberg obstetrical forceps reveals that not a single severe fetal injury could be attributed to the use of this instrument. Moreover, the excellent five and ten minute Apgar scores following delivery using the Bamberg forceps further support our view that it is a safe instrument. The helmet effect provided by the blades of these forceps limits the constant contact pressure and protects the fetal cranium from injury during birth.

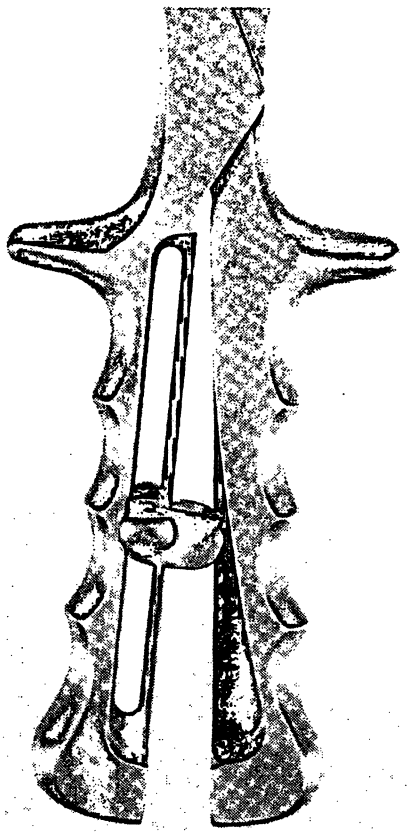

Figure 9. Bamberg divergent forceps: Excentric in the right handle and friction groove in the left handle. With the blades applied, the excentric is pushed forward with normal manual pressure (2 kp) until it blocks. Slippage of the blades is then effectively prevented.

The Bamberg forceps is also ideally suited for mid- or low-mid forceps rotations and deliveries. The excentric slide on the instrument automatically locks in place. This reduces the likelihood of slippage and allows for a considerable degree of traction to be safely applied. Moreover, the moderate pelvic curve of the blade limits fetal and maternal trauma during the process of forceps rotation.

The Bamberg forceps, as with most other obstetrical instruments, can readily be applied under pudendal or saddle block. Application of the forceps is relatively simple. The blades are locked, as illustrated in figures 8 and 9. Note that each handle is separately guided into a position which allows the pivot and the cavity of the lock to cross each other. Simple thumb pressure enables the application mechanism to be moved towards the blades. Following delivery of the head, the application mechanism is shifted backwards by simply using the thumb and the first finger of the (right) hand. Disengagement of the forceps is achieved by simply compressing the handles.

The distinct advantage of being able to apply the cup to the fetal head prior to full cervical dilatation has earned for the vacuum extractor a permanent place in the obstetric armamentarium. In most situations where instrument delivery is required, however, the time required to obtain good application of the vacuum cup to the fetal head, limits its use. In such cases, provided the cervix has attained full dilatation and the fetal head has engaged the pelvis, the forceps offers a far better option. Moreover, it is possible to exert a much greater degree of control on the fetal fead using the forceps than the vacuum extractor.

We submit, based upon the data presented above, that when opting for forceps delivery, the Bamberg forceps is an ideal choice.

Summary

The design and use of a divergent obstetrical forceps, which was developed at the Staatliche Frauenklinik und Hebammenschule in Bamberg by SIPLY and KRONE are presented. The major advantage associated with the use of this instrument is that it permits the exertion of a limited constant application force (max 300 g) on the fetal head. Thus, compression injuries are effectively prevented and slippage of the forceps with resultant trauma is precluded.

The Bamberg forceps was evaluated at the Frauenklinik und Poliklinik der Technischen Universität München and at the Staatliche Frauenklinik und Hebammenschule Bamberg, Federal Republic of Germany. An evaluation of 483 cases where this forceps was used is presented. No serious complications directly attributable to the use of this instrument could be documented.

Keywords: Fetal outcome, forceps delivery.

Zusammenfassung

Erfahrungen mit der „Bamberger Divergenzzange"
Der Hauptvorteil der Konstruktion der „Bamberger Divergenzzange", die erstmals 1975 von SIPLI und KRONE vorgestellt wurde, liegt in einer begrenzten und konstanten Anlegekraft von maximal 300 g. Durch diese geringe, auf den kindlichen Kopf wirkende Kraft werden Kompressionsschäden sicher vermieden. Die konstante Anlegekraft verhindert auf der anderen Seite ein Abrutschen der Zangenlöffel und hieraus resultierende Abschürfungen.

Diese an der Bamberger Frauenklinik entwickelte Zange wurde kurz danach an der Frauenklinik und Poliklinik der Technischen Universität München ebenfalls eingesetzt. Es wird hier ein Erfahrungsbericht über insgesamt 483 mit diesem Instrument durchgeführte vaginale Entbindungen vorgelegt.
Es konnten keinerlei ernsthafte mit der Benutzung der Zange in Zusammenhang stehende Komplikationen registriert werden.

Schlüsselwörter: Forceps-Entbindung, kindliche Verletzungen.

Résumé

Expériences avec la pince obstétrique de Bamberg
La pince divergente de Bamberg a été présentée en 1975 par SIPLI et KRONE. Son principal avantage résulte de la force d'une pression constante et réduite à 300 gr. Du fait de la faible pression exercée sur la tête de l'enfant, il n'y a plus de risque de lésion de compression ni d'éraflure causée par la branche de la pince qui s'échappe, ceçi grâce à la construction spéciale.

Cette pince conçue et mise au point à la maternité de Bamberg a été employée un peu plus tard à la maternité et dans la policlinique de l'université de Munich.
Il ressort du rapport paru à la suite de 483 accouchements pratiqués à l'aide de cette pince dans les deux hôpitaux qu'aucune complication serieuse n'a pu être attribuée à l'emploi de cet instrument.

Mots-clés: Accouchements par forceps, blessure de l'enfant.

References

[1] BELLER FK, K QUAKERNACK: Geburtsunterstützung durch die Beckenausgangszange. Med Welt 28 (1977) 1665
[2] CHAMBERLAIN G: Forceps and vacuum extraction. Clin Obstet Gynaecol 7 (1980) 511
[3] CUTTER B: Laufe's divergent forceps. The Canberra Experience. Aust N Z J Obstet Gynaecol 15 (1975) 215
[4] DOUGLAS RG, WB STROMME: Operative Obstetrics. Third Edition. pp. 461–465. Appleton-Century-Crofts, New York 1976
[5] O'DRISCOLL K, D MEAGHER, D MACDONALD, F GEOGHEGAN: Traumatic intracranial haemorrhage in firstborn infants and delivery with obstetric forceps. Br J Obstet Gynaecol 88 (1981) 577
[6] ENDL J, G WOLF, A SCHALLER: Röntgenuntersuchungen am kindlichen Schädel nach Vakuumextraktion; Probleme und Ergebnisse. Geburtshilfe Frauenheilkd 35 (1975) 943
[7] FORSTER FMC: On modern forceps delivery and Laufe's divergent forceps. Aust N Z J Obstet Gynaecol 15 (1975) 209
[8] HEALY DL: Design errors in Kielland's forceps. Aust N Z J Obstet Gynaecol 22 (1982) 31
[9] ISSEL EP: Zur mechanischen Einwirkung der geburtshilflichen Zange auf den fetalen Schädel. Zentralbl Gynaekol 99 (1977) 487
[10] KRIEGLSTEINER P, HA KRONE, D v ZEPPELIN: Die weiterentwickelte Bamberger Divergenzzange. Modifikationen zur Vermeidung pelviner Weichteilverletzungen. Geburtshilfe Frauenheilkd 44 (1984) 767
[11] LAUFE LE: A new divergent outlet forceps. Am J Obstet Gynecol 101 (1968) 509
[12] LAUFE LE: Crossed versus divergent obstetric forceps. Obstet Gynecol 34 (1969) 853
[13] LIVNAT EJ, M FEJGIN, A SCOMMEGNA, J BIENIARZ, L BURD: Neonatal acid-base balance in spontaneous and instrumental vaginal deliveries. Obstet Gynecol 52 (1979) 549
[14] MALMSTRÖM T: Vacuum extractor – an obstetrical instrument. Acta Obstet Gynecol Scand [Suppl. 4] 33 (1954) 23
[15] MALMSTRÖM T: Der Vakuum-Extraktor. Arch Gynaekol 198 (1963) 512
[16] MOOLGOAKER AS, SO AHAMED, PR PAYNE: A comparison of different methods of instrumental delivery based on electronic measurements of compression and traction. Obstet Gynecol 54 (1979) 299
[17] PLAUCHE WC: Fetal cranial injuries related to delivery with the MALMSTRÖM vacuum extractor. Obstet Gynecol 53 (1970) 750
[18] QUAKERNACK K, FK BELLER: Die Laufe-Zange. Ein empfehlenswertes Zangenmodell zur Beckenausgangszange. Geburtshilfe Frauenheilkd 35 (1975) 295

[19] Seidenschnur G, J Heinrich, E Koepcke, H Hopp, H Hamann, U Koenig: Zur Frage des Schädigungsrisikos bei Entbindungen durch Shute forceps (Analyse von 1016 Forcepsentbindungen). Zentralbl Gynaekol 99 (1978) 1286

[20] Selbmann HK: Münchner Perinatal-Studie 1975–1977. Dtsch Ärzte-Verlag, Köln-Loevenich 1980

[21] Shute WB: An obstetrical forceps which uses a new principle of parallelism. Am J Obstet Gynecol 77 (1959) 442

[22] Sipli W, HA Krone: Ein neues Zangenmodell – Bamberger Divergenzzange: Geburtshilfe Frauenheilkd 36 (1976) 592

[23] Stech D: Die Anwendung vaginaler geburtshilflicher Operationen bei Schädellagen. Med Klin 44 (1963) 1785

Received November 7, 1984. Revised June 19, 1985. Accepted July 9, 1985.

Prof. Dr. Peter Krieglsteiner
Frauenklinik
im Malteser Krankenhaus
von Hompesch-Straße 1
D-5300 Bonn 1, Fed. Rep. Germany